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ABSTRACT

Commissioned by the Scottish Executive Education Department, this review focuses on research into the possible associations between health and pupils' school attainment. Looking particularly at recent research from the United Kingdom, Europe, Australia, New Zealand, and North America, the review covers research into the effects on attainment of physical health (including illnesses and physical exercise), nutrition, risk behaviors (such as substance misuse), and mental health (including behavioral problems). The review highlights the following conclusions: (1) the various findings about the relationship between educational attainment and health are confounded by other influential factors, such as school and community characteristics; (2) while schools cannot address all social problems, research suggests that there are areas in which school interventions may make a difference, especially those that increase probability of school attendance; and (3) there are no longitudinal studies of the nature required to clarify firm associations between health and school attainment in Scotland. Contains 160 references. (EV)

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Health and Attainment

A Brief Review of Recent Literature

Janet Powney
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Health and Attainment

A Brief Review of Recent Literature

Janet Powney
Heather Malcolm
Kevin Lowden

The Scottish Council for Research in Education

SCRE Research Report No 101

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A report arising from the review of literature on health and attainment commissioned by the Scottish Executive Education Department and carried out between January and March 2000.

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Executive Summary

Purpose and parameters of the review

This review was commissioned by Scottish Executive Education Department from the Scottish Council for Research in Education and was carried out between January and March 2000. It focuses largely on research concluded over the previous 10 years. The review addresses the following questions:

1. What research relates to associations between health and pupils' school attainment as measured by public examinations or teachers' assessments?
2. Have initiatives in the health promoting school arena produced evidence of an association between health and subsequent pupil attainment?

The reviewers were asked to include only research studies which:

- Involved pupils in the years of compulsory schooling (5–16).
- Had been completed in the last ten years (although earlier findings of particular import could also be included).
- Had been conducted in the UK and Europe (especially France and Holland), plus Australia, New Zealand, and North America.

Physical health and attainment

- The effects of physical health on attainment are more pronounced for children at risk and in poverty. These children are more likely to suffer a range of illnesses, which impacts on the time they spend at school learning. Simply being poor is associated with poor health, which in turn has a detrimental effect on learning.
- Certain illnesses, which impair senses important to learning, such as hearing or speech, seem to have a particularly detrimental effect on attainment.
- A range of other physical health factors, both environmental and inherited can play a role in limiting learning. These include the effects of passive smoking, high blood lead levels, anaemia and even the level and quality of light.
- Physical exercise has been associated with higher motivation at school, reducing anxiety and depression, and therefore, with a positive effect on schoolwork.

Nutrition and attainment

- The research literature on the possible relationship between nutrition and attainment is extensive. Much of this literature indicates that nutrition can affect learning and attainment. Many studies report that better nutrition has positive influences on: neurological development of the brain; cognitive processes; and short-term and long-term attainment, and behaviour conducive to learning.

- However, there is considerable debate over the claims of such studies. Many of those have found no effects of nutrition and dietary supplements. There have also been inconsistencies in the research design of studies based in the UK which makes comparisons and replication difficult. Therefore, the picture is inconclusive. What appears to be clear is that effects of nutrition are bound up with other factors such as family, community, and levels of poverty.
- Evaluations of special programmes, such as breakfast programmes in Scotland, are on ongoing and should hopefully provide further evidence of the association between nutrition and attainment.

Mental health, risk behaviours and attainment

- Poor mental health can manifest in a range of problem behaviours that can affect concentration, and cause difficulties and low achievement at school itself.
- Some studies highlight that risk taking involving behaviours that affect physical and mental health, such as substance misuse, can have a long term detrimental effect on health, particularly, where substances affect brain function and personality. Misuse of certain substances including alcohol, tobacco and illegal drugs is associated, for some pupils, with lower school grades and negative attitudes to school.

Conclusions

- These various findings about the relationship between educational attainment and health are confounded by the presence of other influential factors. Children fail in school for numerous reasons, and reasons for failure may also be found in the characteristics of the schools and the communities in which children fail.
- No education system can hope to address all social problems yet its outcomes are likely to be affected by them. However research suggests that there are areas in which school interventions may make a difference, especially those that increase the probability of pupils' attendance at school.
- There are no longitudinal studies of the nature required to clarify firm associations between health and school attainment in Scotland.

1: Introduction

1.1 Purpose and parameters of the review

This review was commissioned by Scottish Executive Education Department from the Scottish Council for Research in Education and was carried out between January and March 2000. It focuses largely on research concluded over the previous 10 years. The review addresses the following questions:

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- Had been completed in the last ten years (although earlier findings of particular import could also be included).
- Had been conducted in the UK and Europe (especially France and Holland), plus Australia, New Zealand, and North America.

As far as possible, these parameters have been kept to. However, in some areas relevant to the review the literature is rather thin (there are few evaluations of the educational outcomes of school feeding programmes, for instance). In such cases we have gone beyond the original parameters to include the best evidence we could find.

1.2 Criteria for identifying studies

'Attainment' was taken to be achievement in public examinations or as measured by teacher assessments.

It was less straightforward to define health criteria to make sure that studies would be relevant to the review, especially since the literature search uncovered relatively few studies which yielded direct evidence of a connection between health and attainment. It did, however, bring to light many in which issues of health were subsumed within studies of social disadvantage – in other words, which addressed the topic indirectly. A systematic way had to be found for identifying those studies which reported findings relevant to health and attainment outcomes.

We felt it imperative that both mental and physical aspects of health should be encompassed in our definition and therefore covered in the review, but felt that the link between special educational needs and attainment would warrant its own, separate, review. We considered the inclusion of studies of the effects of poverty, or indeed any form of social deprivation (often associated with poor health, among other factors), on attainment. Our eventual decision was to give precedence in the review to all studies which offered direct evidence relating to the research questions listed above (provided that they matched our criteria in

other ways), and to include studies of social disadvantage when other, reputable research, showed clear evidence linking that disadvantage to poor health.

1.3 The nature of evidence

In general the notion of seeking out and using the best evidence available has been our guide, and most of the review is built on published articles from highly reputable sources. Where occasionally we have referred to unpublished work or studies whose provenance is unclear, we have made this plain in the text. Where the methodology of particular studies was known and important to the findings, we have explained them, but have otherwise concentrated on findings alone.

The findings of some of the studies of health and attainment were expressed in 'hard' numeric terms. Findings in other studies consisted of claims. We have made it clear throughout the review which kind of evidence each study presented.

Throughout the review, but especially in the lengthy section on nutrition, we have been grateful for the help of a number of reviews, such as that by Pollit and Matthews (1998). In presenting the findings of these reviews we have tried both to make it clear when further references belong properly to the review and when not, and to reflect the reviewer's conclusions fairly. All the relevant references encountered, whether of single articles, reviews, or references made within the reviews, are listed in the Bibliography.

In the course of reading we have inevitably been directed to other studies which in turn have indicated more potential sources. In the limited time available it has not been possible to pursue all leads. This review makes no pretension to being comprehensive: rather it was intended to be an introduction to the literature and the Bibliography will point interested readers in further directions.

1.4 Organisation of the review

Apart from this Introduction, the review is structured in two parts which are reversed from the conventional order. The first part, 'What does research say about health and pupil attainment?' draws together the main findings from the literature in relation to the two principal research questions (as set out in 1.1), and provides an overview and conclusions based on this evidence.

In the second part, we review the research evidence from the past 10 years that supports the conclusions related to three aspects of health and attainment:

- How is physical health related to attainment? Studies included here pertain to low birth weight, common illnesses, deafness and speech defects, exposure to smoking, the value of physical activity and the effects of different types of light and nutritional studies as they relate to achievement.
- What are the effects of nutrition on attainment? This section covers nutritional studies as well as evaluations of breakfast programmes and other nutrition interventions.

- How are mental health and risk behaviours related to attainment? This section on mental health covers work relating to psychological stress (exposure to violence, persistent childhood habits) and to the risk behaviours of drug abuse and sexual behaviour resulting in pregnancy.

We would like to stress that although convenient it was clearly artificial to make separations of the kind implied by these sections: many of the conditions covered by the review are interrelated.

2: What does research say about health and pupils' attainment?

The research detailed in this review indicates ill health is likely to affect pupils' attainment. However, it is difficult to demonstrate direct positive correlations between specific health initiatives and improved attainment.

Some recent initiatives such as the Health Promoting School and Social Inclusion Partnerships may compensate for the general deleterious effects of poverty, but as few of these projects have been evaluated, it is too early to be sure of their effects.

2.1 Physical health

Children having low weight at birth are more likely than other children to be held back at school or require learning support, as the medical problems of their infancy translate into learning and behaviour problems. Children who suffer frequent common illnesses are more likely than children in general to have learning problems, either because they spend more days away from school and so have less time in which to learn or, in the case of those with ear infections, because they have difficulty hearing and interpreting what they hear.

In many of the studies, the effects, whatever they are, are more pronounced for children at risk. The plight of homeless children seems to illustrate this as they fare particularly badly, suffering especially often from illnesses and being away from school; and while children who are in the care of relatives are much better off than the homeless, these children still have more health problems than others and score below them in cognitive and language tests. Simply being poor is associated with ill health, especially with high blood lead levels and anaemia, and poor children generally are more likely than those who are not poor to have learning problems and developmental delays.

There is an association between children's exposure to passive tobacco smoking and having to repeat a grade in school - and having to repeat a grade has its own adverse effects on learning and motivation.

On the more positive side, there are studies that illustrate the benefits of physical exercise, which in pupils is associated with doing better at school, with the lifting of depression and anxiety, and with reduced tiredness. There is even some evidence that working beneath the right kind of light might help raise achievement scores (and reduce caries).

Turning to the link between nutrition and achievement, although the body of literature in this area is vast, it is somewhat inconclusive. Anthropometric studies have sought, and claimed to find, relationships between head circumference and IQ and the explanation has been offered that better nutrition promotes the neurological development of the brain, but this explanation remains speculative. It is clear from studies of early pregnancy, however, that getting nutrition right is of prime importance, with the adverse consequences of

getting it wrong following children from early into late childhood; and not surprisingly, nutrition continues to be important for short and long-term attainment as well as patterns of behaviour throughout the school years. It is not easy, however, to prove exactly why it is important or how important it is.

The experimental studies of the effect that nutrition has on achievement in the short term are contradictory. It has been claimed that nutrient input can improve performance on immediate recall tasks and reduce errors, but out of nine studies covered in this review, five found correlations between nutrient intake and children's performance on tests and four did not. Perhaps importantly, most of the studies which found no effects of a dietary supplement were conducted in the UK. There are, however, many explanations of the inconsistencies: participant samples differed in background, culture and age, for example, and the nutritional values of the various breakfasts varied as did the timing of the studies.

There seems, however, to be agreement that such adverse effects as there are in fasting are more pronounced in nutritionally at risk children.

Studies that have focused more widely on the effects of malnutrition in relation to achievement are less contradictory, but researchers themselves admit that confounding factors prevent easy conclusions. Long-term effects are claimed to include irritability, apathy, physical inactivity, and lack of concentration – all of which militate against learning. Children who are obese as a result of malnutrition risk ostracism from their peers. There is also a circularity about the arguments: malnourished children are at greater risk of infection, so are ill more often, so miss school more often, so do less well in lessons.

2.2 Mental health and risk behaviours

The studies covered for this review show that poor mental health can be manifested in a range of problem behaviours. Some are persistent habits from early childhood: bedwetting and soiling, eating and appetite problems, headaches and stomach upsets. Headaches and upset stomachs have also been associated with severe psychological stress, especially exposure to violence, as has fearfulness, withdrawal, lack of concentration and low self esteem. In all cases, studies have shown that such behaviours are linked to difficulties at school and low school achievement.

Some studies provide evidence that adolescent pupils who take drugs, including tobacco and alcohol, have lower grades, more negative attitudes to school and more truancy than non-drug users; and there is also evidence that drugs can interfere with brain and personality functions. Some researchers have confirmed that school-age women who bear children have lower grades, take less part in school life and are less likely to finish school than their peers. They are also likely to risk further pregnancies.

2.3 Effectiveness of school-based health promotion initiatives

In the course of this review we found few evaluations of school health initiatives which focused on the benefits of promoting health for educational attainment. Much of the little there was came from the developing world. There is some evidence, though slight, that school-based physical activity programmes can increase pupils' concentration, reduce disruptive behaviour and improve mathematics, reading and verbal scores, and one fitness programme in Glasgow schools is claiming positive results though at the time of writing not enough is known about its evaluation to let us be more specific.

Recent HMI and government publications (SEED 1999a, 1999b) on health promotion are primarily concerned with the provision of information and guidance for schools to facilitate the teaching of effective health education. However, the assumption running through these documents is that:

> *When children and young people are fit and healthy, they are more able to concentrate, learn and do well at school.*
>
> (SEED 1999b)

The education potential of young people is seen as being influenced by health, but also their health is seen as being strongly influenced by education and their skills. This latter view underpins much of health education and health promotion philosophy. The White paper, *Towards a Healthier Scotland* (1999) emphasised the concept of the health promoting school as a key component in the health of the nation and the new community school initiative.

Government reports (SEED 1999a, 1999b) highlight that elements of good practice in health promotion have been identified in schools and education authorities across Scotland by HMI and can be implemented in schools' development planning cycles, either as a discrete issue or across other action plans. These examples of good practice are based on the expertise of HMI but do not have empirical evidence of the long-term impact of health promotion on pupils' education attainment.

Given the interest in school-based nutrition programmes as part of health promotion, especially in the United States, we were surprised to find so few evaluations that focused on academic improvements. One large American study, conducted over a year in the late '80s, found that participation in the national breakfast programme improved both test scores and attendance rates, and evaluations of breakfast programmes in Jamaica and Peru also found that attendance rates improved. Positive effects were most evident among the most malnourished children, but whether these stemmed from improvements in their diet or the increase in hours at school is not known. A World Bank team concluded that the link between nutrition and learning was too slight to be of great importance, but clearly there is a need for long-term evaluations of the effects of nutritional and other school-based health programmes on achievement.

2.4 Summary

To sum up, health (and particularly nutrition) are important influences on attainment throughout a child's life, from before birth through to the end of his or her schooldays. On specific short-term issues, studies seeking to link health with attainment are inconsistent, but in the longer term the research consistently points to adverse effects of ill health on attainment.

However, these findings are confounded by the presence of other influential factors. As Byrd and Weitzman (1994) point out, children fail in school for numerous reasons. These include health and behaviour, but other reasons for failure may be found in the characteristics of the schools and the communities in which children fail. Social background is important (Grantham-McGregor, 1990; Karp and colleagues, 1992; Byrd and Weitzman, 1994) as are factors in the educational system and in the children themselves (Ivanovic and colleagues, 1991). What seems clear is that most of the conditions described are the attributes of poverty; the research seems to be saying that children at risk, whether from inadequate nutrition, homelessness or exposure to violence, are the most vulnerable to whatever ill effects there may be and their education is likely to suffer.

No education system can hope to address all these problems, yet its outcomes are likely to be affected by them. So what can usefully be taken from the research? The research suggests there are areas in which intervention can make a difference: on a purely mechanistic level, if it helps children to work under full spectrum light with a UV enhancement rather than under high pressure sodium vapour lighting, it might make sense to fit the former into new school buildings.

On a more complex level, many studies point to the importance of a child's simply **attending** school. Ill health makes absences likely. Conversely, some of the nutritional programmes in the US and in the developing world are succeeding in raising attendance rates through the attraction of giving hungry children something to eat. In areas where there is known to be widespread malnutrition, there is a real chance that breakfast and lunch programmes can make a difference. And although it has not been proven that breakfast programmes improve school attainment, the evidence strongly suggests that they improve school attendance among those groups most in need of such improvement, and at the least they ensure that the children receive a meal.

Many of the researchers whose studies are reported here have called for additional longitudinal studies. Certainly we found few studies that had been conducted in the UK or, indeed, continental Europe: if they exist they are inaccessible to a brief survey such as this. Some of the studies we have included in this review were conducted in the developing world (e.g. Jamaica) but most were US-based, conducted on low-income-groups that were often from African-American or Hispanic populations. The contexts of such research does not resemble that of Scotland and it cannot be assumed that findings which are valid there have relevance elsewhere. Medium and long term Scottish evaluations of the effects of physical fitness programmes as well as of breakfast and lunch

clubs might help firm up some of the claims reported here. Certainly there are many activities currently concerned with improving pupils' health: attainment outcomes in Health Promoting Schools and New Community Schools should be explored for evidence of the relationships between health and attainment.

2.5 Implications for future policy and development

There is still much debate in the literature on health and attainment about how health affects attainment. There is evidence that where health influences attainment, there is also an interplay of other factors which include poverty and family and community effects. Therefore, measures which aim to have a positive impact on the health of individuals - and do so by addressing the holistic nature of health – are also likely to promote school attainment. This is a topic area where there are complex, inter-related processes involved, health appears to influence education and education can influence health but also the wider social context provides determinants. Nevertheless, there does appear to be enough evidence from research to suggest that, with this complexity in mind, certain measures can help improve health and have the potential to improve educational attainment. Some of these measures will include:

- Promoting healthy eating, particularly during pregnancy and early years.
- Reducing risk behaviours, particularly substance misuse.
- Promoting healthy environments free from toxic substances such as passive tobacco smoke and other harmful airborne particles. Even the provision of lighting which is either natural or emulates sunlight seems helpful.
- Initiatives to promote pupils' attendance at school.

Health promotion and education will have a role to play in the above, but the social circumstances of individuals will either facilitate or inhibit the extent to which people can take up the opportunities provided by interventions. It will therefore be especially important to establish baseline indicators of relationships between health and attainment and to monitor the impact of health promotion and social inclusion initiatives on pupils' attainment.

3: How is physical health related to school attainment?

3.1 Health and school performance

In 1992 and at the behest of the American Academy of Paediatrics and the Parent Teacher Association, the Porter/Novelli PR Agency investigated teachers' perceptions of the relationship between their pupils' health and academic performance (Porter/Novelli PR Agency, 1992). 250 kindergarten grade 3 teachers and 250 4th–6th grade teachers took part.

The findings revealed a growing concern among teachers about children's health and the way it affected their school work:

- 94% of respondents agreed that children's overall health was very important to school performance.
- Overall, teachers estimated that 12% of their students from the previous year had health problems hindering their academic performance.
- 64% of all respondents reported more children with health problems than in previous years.
- Teachers felt that helpful school practice would include teaching students about good health (97%) and the provision of nutritious meals (87%).

This is the only general study undertaken in the United States, and it draws on teachers' perceptions rather than statistics. However, the fact that it was commissioned by the PTA as well as the American Academy of Paediatrics indicates concern among parents and paediatricians as well as teachers in the US, about children's health as it relates to school performance.

The current review uncovered a vast literature of studies focusing on numerous aspects of physical health and performance, most of them very specific. It begins with the literature related to low birth weight.

3.2 Studies of low birth weight

There is a considerable body of recent research into correlations between achievement and measures of physical health, one of which is low birth weight. In a large study in the US, Byrd and Weitzman (1994) found low birth weight to be one of the health factors independently associated with increased risk of low grade retention (the others were poverty, male gender, low maternal education, deafness, speech defects, enuresis and exposure to smoking). The study concentrated on nearly 10,000 nationally representative children aged 7–17 who repeated kindergarten or first grade. Data were derived from interviews with parents and were subject to rigorous statistical analysis. The researchers comment that the study:

> *Demonstrates that a number of extremely common child health problems are independently associated with early grade retention and that the magnitude of the heightened risk associated with these problems is similar to that of social risk factors. Moreover ... these data confirm that multiple risk factors are found to have cumulative effects in increasing a child's risk of early school failure.*

Mohay and colleagues (1998) studied 114 Australian children with birthweight so low that mechanical ventilation after birth had been needed. At each child's ninth birthday, parents and teachers were sent a postal survey which used recognised tests. Respondents were asked about behaviour (which the researchers then classed as 'normal' or 'disturbed'), about the children's health, and about the children's achievement (difficulties in reading, writing, spelling and mathematics). They found that:

- 29% of the children were regarded by either parents or teacher or both as having behaviour problems.
- 51% were regarded by either parents or teacher or both as having learning problems at school.
- Teachers reported the occurrence of behaviour and learning problems as related.
- 42% of the children had at least one asthma attack which had needed medical treatment (but 25% of children in the Queensland population have this).

Mohay and colleagues conclude that the risk of serious disability among these children is quite small but that:

> *The problems they experience appear to have shifted from the medical problems in infancy to educational and behavioural problems in the school years.*

Other research supports this finding. In the course of an investigation to estimate the real cost of caring for low birth weight children, Lewitt and colleagues (1995) state that there is evidence of higher incidence of neurologic impairments or chronic health conditions in low birth weight children compared to others, and that they exhibit a greater likelihood of experiencing difficulties at school. In support of this they cite two studies: Chaikin and Corman (Lewit *ibid*) and Corman and Chaikin (Lewit *ibid*). In the first of these the researchers, focusing on the impact of low birth weight on special education costs, found that:

> *After controlling for a number of individual, family and regional factors, children ages 6-15 who weighed less than 2,500 grams at birth were almost 50% more likely than normal birth weight children to be enrolled in some type of special education program.*

For the second study, Corman and Chaikin investigated the effect of low birth weight on health behaviour and school performance. They found that:

> *Particularly for children ages 11–15, low birth weight children, whether in special education or not, are more likely to have repeated a grade at some point in their schooling than normal birth weight children ... About 31% of low birth weight children will repeat a grade by grade 10 compared to about 26% of normal birth weight children.*

An association between birth weight and school attainment was also found in a Scottish study. Hall and colleagues (1995) reviewed the prevalence of learning problems and of cognitive and motor impairment among a population of 8–year–olds with very low birth weights and comparable groups in terms of gender and age. Fifteen percent of those with birthweight of less than 1000g and six percent of those weighing 1000–1499g attended special schools. Low birth weight children in mainstream schools performed significantly less well in tests of neuromotor function than their comparison groups. Their mean IQs were 90.4 and 93.7 for those below and above 1000g, respectively, while their comparison groups' IQs were 102.5 and 101.2. In all cognitive subscales apart from that testing short-term auditory sequential memory, both low weight groups were less competent. They were also less able in basic reading and number skills. These children placed heavy demands on mainstream schools, with 52% and 37% of the low weight groups, respectively, requiring learning support compared with 16% in the comparison groups.

3.3 Common illnesses

Pollitt (1994) draws on research in Kenya and Thailand to suggest that common illnesses are relevant to educational development. While acknowledging that there are differences between developing nations and the United States, Pollitt argued that such findings have relevance because 'The frequency of common illnesses and the number of days ill among poor minority children [in the US] might be larger than what is generally expected'. In light of recent findings among Glasgow children (Blackburn, 1998) this argument may also have relevance to Scotland.

Pollitt (*ibid*) reports that, in Neumann and colleagues study of 7–9-year old Kenyan children, the number of days ill in early childhood correlated to their cognitive test scores, while in Thailand, children with iron deficiency but no anaemia performed significantly worse than iron-sufficient controls in school achievement tests (Pollitt, Hathirat, Kotchabhakdi, Missell and Valyasevi, 1989).

3.4 Deafness and speech defects

Statistical analysis of the data relating to almost 10,000 school-age children led Byrd and colleagues to report a trend for children who had suffered frequent ear infections to be at risk for early grade retention – which according to Shepard and Smith, 1990 (cited in Corman and Chaikin, 1993) in itself makes it more likely that children will drop out of school. Byrd and colleagues also confirmed other findings which suggested that *otitis media* resulted in delays to speech and language development and might predispose children to educational difficulties

with verbal skills (Teel and colleagues, 1984), auditory processing of information (Webster and colleagues, 1989), attending to auditory cues, and more hyperactive-like behaviour with increased distractibility (Adesman and colleagues, 1990; Roberts and colleagues, 1989).

Pollitt (1994) cites further evidence from the United States to suggest that ear inflammations will interfere with language development (Marshall and colleagues, 1984) and that this could in turn affect later school learning. Pollitt acknowledges, however, that the causal link remains to be established.

3.5 Exposure to smoking

The work done by Byrd and colleagues found that children's passive exposure to tobacco smoke was independently associated with an increased risk of retention in early grades. Their article cites other studies to have provided evidence of long-term behavioural, intellectual and educational problems associated with such exposure (Weitzman and colleagues, 1992; Butler and colleagues, 1973; Rantakallio, 1983; Naeye and Peters, 1984), but Byrd and colleagues state that theirs is the first study to have used a nationally representative sample to establish such an independent association.

3.6 The special case of homeless children and those in the care of relatives

Homeless children in particular seem to be at risk of illness, at least in the US. Molnar and Rath (1990) reviewed 'the small body of research' on the impact of homelessness on children. One of their conclusions was that homeless children are ill more often than children are in general, suffering more respiratory infections, ear infections, gastrointestinal problems, skin ailments, poor teeth, chronic health problems like card ac disease, peripheral vascular disorders, endocrine dysfunction, and neurological disorders (Wright, 1993).

Molnar and Rath, citing Rafferty and Rollins (1989), also found evidence that homeless children had poorer school attendance levels at all grades than the general population. What is more, their attendance rates declined at a faster rate than for students in the system as a whole. Rafferty and Rollins also examined the reading and math scores of students in temporary housing who participated in the New York City public schools' citywide testing program, and compared the scores to those obtained systemwide. In reading, less than half the homeless students at grades 3–10 who took the reading test scored at or above grade levels compared to 68% of all New York students. In maths, among students in grades 2-8, 28% of homeless students scored at or above grade level compared to 57% of all New York students who took the test.

Molnar and Rath further cite Bassuk and colleagues who found that, among their sample of 50 school-aged children living in Boston shelters, the mothers reported that 43% had missed a grade and that 43% were failing or performing below-average work. Rafferty and Rollins had reported that 42% of students

living in temporary housing in New York City were one year or more over age for their grade level.

According to work by Dubowitz and colleagues (1994) (not included in Molnar and Rath's review) children in 'kinship care' fare rather better than homeless children but are still at some disadvantage compared to the wider population. Dubowitz and colleagues attempted to study all children in the care of relatives in Baltimore, in relation to health and behaviour. In a sample of 407 children they found anaemia, asthma and dental problems to be common but not serious, although 'compared with American children in general, children in kinship care appear to have many more health problems'.

Teachers rated approximately half the children in kinship care below average in core subjects and rated them as frequently having problems: demanding attention, overactivity and aggressive behaviour.

With respect to school performance and behaviour, Dubowitz and colleagues worked with a sample of 372 school age children, gathering information through questionnaires, teacher ratings and a range of tests (e.g. academic achievement 'CAT', cognitive abilities). They also looked at school attendance and suspension rates.

It was found that children in kinship care scored significantly below comparison groups on academic achievement, cognitive and language skills. Teachers rated approximately half these children below average in core subjects and rated them as frequently having problems such as demanding attention, overactivity and aggressive behaviour. However, Dubowitz and colleagues found no correlation between the children's achievement test scores and either physical health or behaviour problems. They stress that their findings may not be generalisable.

3.7 Poverty and ill health

Like the homeless, poor children suffer high instances of adverse health, especially high blood lead levels and anaemia (Oski, 1993). Hofferth (1998) analysed information from a large longitudinal study of 3,586 children in the US, this information being gathered through parent interviews and surveys, with measures of achievement coming from standardized tests. She found that 41% of children in poverty are in top physical health, compared to 52% of children who are not poor. Hofferth's analyses showed that the general measure of children's health as reported by parents was not linked to children's verbal and maths achievement, but it was linked to behavioural problems such as being withdrawn or aggressive: the lower the overall health score, the more likely the behavioural difficulties.

Children living below the poverty line are 1.3 times as likely as children who are not poor to experience learning disabilities and developmental delays (Brooks-Gunn and Duncan, 1997). Brooks-Gunn and Duncan point out that the relationship between income and schooling is not clear because of the many confounding factors such as parental education, family structure and neighbourhood characteristics, and perhaps surprisingly they conclude that 'all

the studies suggest that, after controlling for many appropriate confounding variables, the effects of poverty *per se* on school achievement are likely to be statistically significant, yet small.' A possible explanation of this might be that the environment outside the family matters more to children of school age than it does to children too young to attend school. The researchers see poor health as both an outcome of poverty and as a 'pathway' by which poverty influences other outcomes such as cognitive ability and school achievement.

3.8 Physical activity

If the conditions discussed so far in this review have focused on their negative effects on children's development, the studies of physical activity concentrated on improvements. Symons and colleagues (1997) cite studies claiming to show that **exercise** is associated with improved academic outcomes and reduced incidence of depression, anxiety and fatigue (American Association of School Administrators, 1985; Hechinger, 1992; Gibbons-Laemel and Laemel, 1993; Seefeldt and Vogel, 1986). They further comment that **vigorous physical activity** has been linked to reduced anxiety, tension, depression and reactivity to stressors, all of which improve student attitudes towards themselves and school (Kolber and colleagues, 1986; Bouchard and colleagues, 1990; Gibbons-Laemel and Laemel, 1993). In addition, Kolber and colleagues found school-based activity programs helpful in that they 'increased concentration, improved mathematics, reading and writing scores, and reduced disruptive behaviours'.

A modest but recent and Scottish study reported in *The Scotsman* (Blackburn, 1998) seems to support the American findings. The study, carried out by Fit for Life, Glasgow City Council, Glasgow Health Board and Glasgow University, monitored the health of 30 S4 pupils from 4 secondary schools in Glasgow for 12 months. Ten pupils were given cycles, ten walked and ten were driven to school. The findings included improved fitness among those who cycled and walked, and changed pupils' attitudes to car use. The project manager claimed that 'Being fitter and more healthy equips children better for school life in general. They are more receptive, whereas their mates who have been driven to school are still in the same lethargic state they were in when they got up.'

One example of a school based physical activity programme which claims to have a positive impact on pupils' academic performance is 'The Class Moves!'® programme. Developed in Holland in the period 1988–1992, 'The Class Moves!'® programme consists of a number of relaxation exercises for use with school children (ages 4 to 12) in ordinary and special schools. The exercises are grouped by theme and age and are presented on monthly calendar. The programme encourages children to engage in activity on a daily basis and is based on the principle that these types of activities promote motivation, concentration and positive physical awareness (Sijthoff, 1999). The programme designer states that, at an educational level, the programme is linked to primary education attainment targets including attitude towards working. The objectives of the programme have been evaluated in Holland by the Netherlands Organisation for Applied Scientific Research (TNO) and the departments of

health sciences, human movement sciences, educational sciences at the Free University of Amsterdam. These evaluations indicate that, at least in the short-term, there appears to be some positive impact on pupils, concentration.

A growing body of evidence exists to suggest that children's regular involvement in physical activity can contribute positively to their health status and well-being. Traditionally, this has been associated with physiological benefits such as skeletal growth and health, the modification of risk factors like blood pressure and blood lipids associated with coronary heart disease and the prevention of overweight and obesity (Riddoch, 1998). Additionally, there is an emerging body of evidence that recognises the association between physical activity and the broader concepts of mental, social and moral health in young people (Mutrie and Parfitt, 1998). The ethos of 'The Class Moves!'® is located largely within these domains.

3.9 The effects of light

A study reported on the World Wide Web and conducted in Alberta, Canada (Hathaway and colleagues, date uncertain but post-1989) investigated the effects of four types of lighting on Alberta schoolchildren studying in four different sites. The lighting types were 1) = high pressure sodium vapour lighting; 2) = full spectrum lighting; 3) = full spectrum plus UV (ultra violet) supplement lighting; 4) = cool white lighting.

The researchers gathered background data from participating children including age, sex, dental histories, nutrition histories, general health, growth and development histories, vision histories, attendance histories and scholastic achievement histories. Hathaway and colleagues claim that the study points to significant differences between lighting types when it comes to development of dental caries, gains in height, gains in weight, gains in body fat, gains in achievement, and improvements in attendance. UV lighting helps reduce caries; high-pressure sodium vapour lighting is associated with slower height gains, more frequent absence and lower achievement gains than other forms of lighting. Specifically:

1. The effect on children of receiving trace amounts of UV radiation in their classrooms amounted to 1.75 fewer caries (cavities) per child per year than was the case in the non-UV schools.
2. Children exposed to high pressure sodium vapour lighting were absent 3.2 days per year more than students under full spectrum and full-spectrum with UV enhancement.
3. Gains in body height, weight and body fat were also significantly linked to lighting systems. The smallest gains in height were made under high pressure sodium vapour lighting, while the greatest gains were made under full spectrum plus UV (ultra violet) supplement lighting.
4. Scholastic achievement was significantly linked to light. Students exposed to high-pressure sodium vapour lighting demonstrated the poorest rate of achievement (the Canadian Test of Basic Skills was used to measure this).

3.10 Water and the brain: implications for cognitive functioning

In recent years there has been increasing interest in the effect water consumption might have on the functioning of the brain and, in particular, on cognitive development. Neurological research, much of it from the United States, indicates that encouraging pupils to drink water in classrooms improves behaviour and performance (Times Education Supplement Scotland, 16.6.98). Dehydration is seen as a main cause of apparent boredom, listlessness and lack of concentration among pupils and recommendations have been made that pupils should drink between 8 and 15 glasses of water (or 2 litres) a day depending on the weather, activity levels and body size.

3.11 Vitamin and mineral intake and cognitive development

Research on brain functioning, again, mainly from the United States, strongly suggests that complex brain functions depend on a balance of nutrients, and that nutrient and chemical imbalances can disrupt the functioning of the brain and impair emotional and psychological well being. Foetal and infant nutritional intake of vitamins and minerals is seen as crucial in the development of the brain and its functioning. Certain vitamins, particularly the B series (B1, B3, B6, B12 and folic acid), amino acids and minerals (iron, calcium, magnesium and zinc) are known to be important for brain and nervous system development, maintenance and functioning throughout life (Badash, 1998). The chemical Choline is known to be necessary for learning, memory and alertness. Most of the important vitamins and chemicals necessary for health brain functioning are water-soluble and should be take together for maximum benefit (Vernon and Jeffrey, 1989).

3.12 The impact of environmental pollution on cognitive performance

Water intake is seen as important for cognitive performance and also promotes emotional well being and physical activity. However, the quality of water available for drinking raises an important factor in terms of nutrition, health and attainment – that of environmental pollution. Environmental pollution is now seen by many as a major threat to mental and physical health. Environmental toxins are being associated with a range of developmental disabilities and conditions, including autism, attention deficit/hyperactivity disorder, impaired mental capacity and cerebral palsy. Dr Christopher Williams of the University of London's Institute of Education, reports that certain populations are at high risk of impaired mental development through exposure to potentially dangerous neurotoxins, which he calls Environmentally-Mediated Intellectual Decline (EMID). While small amounts of these environmental toxins might have no immediate effect on adults, children and foetuses are particularly at risk because of the effects that even small amounts of these toxins have on the thyroid, an organ crucial to mental development (Minton, 2000).

3.13 Physical health and attainment : Summary

- The main point to emerge from the literature on physical health effects on attainment is that the effects are more pronounced for children at risk and in poverty. These children are more likely to suffer a range of illnesses, which impacts on the time they spend at school learning. Most of the physical factors are associated with, and are exacerbated by, poverty. Simply being poor is associated with poor health, which in turn has a detrimental effect on learning.
- Certain illnesses, which impair senses important to learning, such as hearing or speech, seem to have a particularly detrimental effect on attainment.
- A range of other physical health factors, both environmental and inherited can play a role in limiting learning These include the effects of passive smoking, high blood lead levels, anaemia, and even the level and quality of light.
- Physical exercise has been associated with higher motivation at school, reducing anxiety and depression, and therefore, with a positive effect on schoolwork.

4: What are the effects of nutrition on attainment?

4.1 Difficulties in comparing nutrition studies

Overall, the studies reviewed so far suggest that children's physical health and educational achievement are connected, and that either can be affected by a wide range of factors: low birth weight, incidences of common illnesses and days away from school because of these, deafness and speech defects, exposure to smoking, amount and type of exercise undertaken and the type of light in which the children work. A factor running through all but the last of these is nutrition, the importance of which is evidenced by the large and long-established body of literature seeking both to establish and untangle the nature of the link between nutrition and educational achievement. Although this review is concerned only with relatively recent research, the literature dates from many years back.

There are, however, real difficulties in interpreting and using the findings from this literature. There are problems of generalisability, of cultural differences between research settings, and of methodology. A further difficulty for the educationalist is that many of the studies were conducted by specialists who were principally interested in psychological or medical effects. They therefore used variables of specialist interest which yield a multitude of correlations, the distinctions between which are often very fine, confusing and perhaps irrelevant for the generalist who wants a simpler picture. The situation is further confused because the findings themselves are often contradictory. Below we have set out as clearly as we can the findings of recent studies relating to nutrition and achievement, and have pointed to such inconsistencies as there are.

4.2 The effects of nutritional changes in early pregnancy

A mother's diet and nutritional balance during pregnancy can have long term effects on her child. Rizzio and colleagues (1997) found strong evidence that neuropsychological development is 'extremely sensitive' to nutrition during early pregnancy. In particular, they found correlations between levels of fatty acids and glucose in the mother during pregnancy and their children's intellectual performance at 7 and 11 years of age. All the correlations suggested that 'poorer maternal metabolic regulation was attended by poorer child performance on standard measures of neuropsychological functioning'. This research was conducted on diabetic women because their metabolisms undergo greater changes than do those of non-diabetic women and are therefore easier to measure, but the authors warn that the implications of their findings may not be limited to pregnancies complicated by diabetes. They conclude: 'Even relatively slight perturbances in endogenous substances during pregnancy may have measurable effects on the foetus and child'.

4.3 Effects of malnutrition on cognitive development

If even slight changes in fatty acid and glucose levels during the second and third months of pregnancy can have effects on intellectual performance when a child reaches 7 and 11 years of age, what are the effects of malnutrition after birth on a child's achievement? In its literature review, a relatively recent working committee in the United States cited scores of articles, some going as far back as the 1930s, relating to the impact of malnutrition and hunger on children's academic performance (Working Committee on Education and Labor, 1994).

The studies reviewed support the idea that malnutrition affects achievement adversely (Allen, 1990; Stitt, 1989; Meyers, 1989). Pollitt (1993) is quoted as stating 'Even moderate undernutrition, the type seen most frequently in the United States, can have lasting effects on the cognitive development of children:

> *...Inadequate nutrition is a major cause of impaired cognitive development and is associated with increased education failure among impoverished children.' Iron deficiency, in particular, is linked to poor cognitive performance and behaviour, and especially with shorter attention spans, lower intellectual scores and perceptual disturbance.*
> (Beard and colleagues, 1993; Pollitt, 1994).

Lewitt and Kerrebrock's own review of the literature on children's nutritional status and cognitive development (Lewitt and Kerrebrock, 1997) confirms that chronic malnutrition in childhood is associated with lower scores on tests of cognitive development (Korenman and colleagues, 1995) and that an important relationship between them remains, even when the effects of other poverty-related factors which also contribute to poor performance are taken into account (Korenman and colleagues). Lewitt and Kerrebrock further note that Brown and Pollit have shown malnutrition after the age of two to be as damaging as malnutrition before two, and that an improvement in diet after two has been shown to bring mental development to near-normal levels (Brown and Pollit, 1996). Experiments with rodents suggest that reduced cognitive capacity in malnourished animals has largely to do with reduced social and exploratory abilities, stemmed from a lack of energy: Brown and Pollit speculate that 'malnourished children lack the energy to play and, thus, learn more slowly. In addition, because they grow more slowly than properly nourished children, they appear younger and are less likely to be challenged to talk, explore and expand their capabilities by their caretaking adults.'

4.4 Longer-term effects of malnutrition

Thus far in its summary of research on nutrition and achievement the current review has focused on studies measuring short-term effects of dietary input. There is, however, some evidence that malnutrition may also affect learning in a less immediate way. According to a review undertaken by Symons and colleagues (1997), Troccoli (1993) found that hungry/ undernourished children are irritable, apathetic and physically inactive, all of which characteristics have a negative impact on learning. They have little energy and find it hard to concentrate. But in addition, hungry/undernourished students are at greater risk of infection, therefore are more likely to miss school and to fall behind in

classwork. And a further outcome of malnutrition can be obesity resulting from excess water (Pollitt, 1995); Symons and colleagues point out that according to Taitz (1983) and Korsch (1986) obesity can cause difficulties at school in that 'even very young children attribute undesirable social characteristics to their obese peers. Risks to self-esteem from ostracism have been demonstrated to [have] a negative effect on learning'.

Stunted growth is traditionally used as an indicator of nutritional status in children (Lewitt and Kerrebrock 1997). A study recently reported in *The Scotsman* (Daly, 2000) was carried out in Glasgow on 226 children between 7 months and 16 years of age who were admitted to the Royal Hospital for Sick Children. It suggests that malnutrition in Scotland, at least among Glasgow's children, is a greater problem than might be thought. Approximately 16% of the children were underweight for their age, 15% had stunted growth, and 8% had muscle wastage. Other characteristics of malnutrition were quoted as being anaemia, rotten teeth and constipation. The leading researcher, Professor Lawrence Weaver, was quoted as saying that only one third of the malnutrition cases uncovered during his study had been recognised.

4.5 Anthropometric studies

A different kind of support for the theory that the quality of nutrition affects intelligence comes from three studies seeking correlations between body measurements and IQ (Lynn, 1989; Ivanovic and colleagues, 1996; Karp and colleagues, 1992). Although Lynne *(ibid)* notes this is a type of research that in recent years has fallen somewhat out of fashion he has been intrigued by evidence from the UK, US, Australia, New Zealand and continental Europe, that children's IQs had increased rapidly over the past half century – even to the extent that many researchers were questioning the validity of the IQ tests. Lynn's argument was that the increase was genuine and was brought about largely by improved nutrition. The study is of particular interest because it was conducted in Britain (Northern Ireland) on Caucasian children.

Lynn measured the maximum head circumference, height and weight of 310 9 and 10-year-old boys and girls in four primary schools, and gave them IQ tests for reasoning, verbal, numerical, spatial and perceptual speed primary abilities, plus total IQ. He found a significant correlation between height, head size and intelligence. Lynn argued that this provided corroboration for the theory that better nutrition promotes the internal neurological development of the brain, in which case increased head size is a correlate, but not a cause, of increased intelligence: 'It is not easy to explain this set of intercorrelations except in terms of the theory that nutrition affects all three variables and hence brings them into positive correlation.' Cognitive stimulation programs like Head Start in the USA may have failed because nutrition and not cognitive stimulation is the major environmental determinant of intelligence. (Lynn *abid*).

Ivanovic and colleagues (1996) also concentrated on the importance of anthropometric measures as indicators of malnutrition and hence impaired cognitive development. Their research is included in this review because of the

outstandingly large sample: they worked with 4,500 inner-city Chilean elementary and high school children to determine the relationship between scholastic achievement and nutritional status. The study measured the percentage of weight, height and head circumference for age, and measured scholastic achievement with a language and mathematics test which was designed for the study, and tested for reliability through a pilot on 320 school children. Ivanovic and colleagues reported in 1996 that head circumference for age was the parameter that correlated best with scholastic achievement test scores (Ivanovic and colleagues, 1996).

The findings of Karp and colleagues (1992) are less clear-cut. They comment that many studies in developing countries have pointed to the relationship between weight, height and cognitive performance in children, but that these have been largely assumed to have little relevance for the developed world. As a result of their study of 91 poor African-American boys and girls between the ages of 4 and 6 in four kindergarten classes in a north Philadelphia school, Karp and colleagues suggest otherwise and comment that 'In contrast to prior reports from the US and about other developed countries, anthropometric measures were related both to academic achievement and to measures of neurodevelopment.'

However, the measures were not found to be consistently related to non-verbal cognitive ability, and the researchers conclude that rather than showing that undernutrition causes learning failure, the measures suggest that prior environmental problems affect the development of thought processes and nutrient intake, which in turn inhibit growth and learning. They further state:

> *The data presented herein ... suggest ... that for undernourished children, growth, non-verbal aspects of neurodevelopment, and learning are all on a 'slow track', reflecting a response to an environment that may be stressful, nonstimulating, or frankly abusive.*

The conclusions reached by Karp and colleagues, while not directly refuting those reached by Lynn, at the least point to complexity in findings related to anthropometric measures and achievement.

The previous studies suggest that malnutrition has long-term effects, and this is indeed likely to be the case. Many of the nutritional studies we encountered in the course of this review, however, focused on the short-term effects of meals (breakfast), or of dietary supplements (on performance in cognitive tests such as those of immediate recall), and it is to these that we now turn.

4.6 Studies of the short-term effects of dietary supplements

Short-term nutritional deficiencies influence children's behaviour, ability to concentrate, and to perform complex tasks (Sherman, 1993).

Our current review examined four articles, two of which were themselves reviews, describing studies which investigated the short-term effects of dietary intake in school-aged children. One (Pollitt and colleagues, 1998) reports three experiments which tested the effects of an overnight and morning fast on

cognition among 9 to 11-year-old children, and are fairly typical of experiments in this group. In all experiments the children were admitted to a research centre on two different evenings, a week apart. They ate dinner, played games or watched TV and went to bed. Next morning they were either served breakfast or not, and at 11am they took psychological tests to assess their recall from working memory, and their competence in discriminating visual stimuli. The consequences of the overnight and morning fast, particularly among the children who were nutritionally at risk, were shown to include slower stimulus discrimination, increased errors, and slower memory recall.

A similar conclusion comes from a large Chilean study reported in 1991 (Ivanovic and colleagues). Although Chilean studies are strictly outwith the parameters of this review, this one is included both because it is one of the few studies to use public examination as a measure of educational achievement and because its large sample suggests the findings are particularly robust. The research focused on '550 Chilean adolescent schoolers graduating from elementary and high school', and investigated the relationship between educational achievement and nutrient intake using 'standard procedures for 24-hour dietary recall' along with the results of national achievement tests in language and mathematics, to assess educational achievement. It was found that 'educational achievement is significantly and positively correlated with nutrient intake'.

Ivanovic and colleagues suggest that the effect of nutrition alone on achievement cannot easily be measured. Socio-economic factors are also important – which creates a methodological difficulty for research.

However, Ivanovic and colleagues concluded that the relationship was also connected to socio-economic and cultural conditions. This made it hard to establish conclusively the explanatory power of the variables in educational achievement, because they are interdependent. In addition, Ivanovic and colleagues point out that educational achievement is affected by factors in the students themselves, in their families, and in the educational system, which cannot easily be separated. Others make a similar point; a US working party review cites work by Grantham McGregor (1990) who suggests that social background in addition to nutrition is important in shaping mental development.

Similar to Ivanovic and colleagues, Behrman and Lavy (1994) highlight the complex nature of health effects on education. They analysed the data from the Ghana Living Standards Survey, as part of a wider research effort by the Policy Research Department (PRD), which looked at the effect of the quality of social services on human capital investment outcomes. They argue that while the literature on child health and nutrition on academic success has concluded that health and nutrition are associated, this literature does not control for the probable "endogeneity of the determination of child health"

Behrman and Lavy (1994) look at the implication of the failure of much research to control for such endogeneity, and provide evidence on the interrelationship between health and schooling. They argue that much of the literature on the

impact of child health on cognitive achievement is questionable. However some experimental 'double-blind' placebo trails (including a study of Jamican school children) are seen as more robust. Nevertheless, they question the findings of most nonexperimental studies which claim to find significant positive effects of health, within the ranges observed in school children, on their cognitive achievement. These studies are seen as not having explored the 'estimation problems' due to behavioural determinants such as family and community variables. Also, they criticise many studies for using limited measures of schooling attainment, such as schooling attendance alone. According to Behrman and Lavy (1994) the 'true impact of child health over the relevant range on child schooling success is not significant'. Attainment is not affected by health alone, but rather, a more complex relationship exists whereby children's home and community influence health and attainment.

4.7 Relationship between breakfast and performance

In a summary of papers from an international symposium on breakfast and performance, Pollitt and Matthews (1998) cite three experimental studies which meet the requirements of the current review (Cromer and colleagues, 1990; Vaisman and colleagues, 1996 reporting two studies in Israel). All tested the effects of eating or not eating breakfast, through cognitive tests administered to experimental and control groups that same morning. Cromer and colleagues, working in the US with well-nourished middle-class children, found no significant differences in performance between the groups, but in the first of Vaisman and colleagues' studies, conducted on children from varied socio-economic backgrounds, the breakfast group scored significantly higher on the immediate recall task. The second of their studies (on a similar sample) showed no differences between the groups on most recall, recognition and learning tests, but all the scores were significantly higher for the children who ate breakfast at school rather than at home. The researchers suggest it is timing which is important here: those who ate half an hour before the tests did better than those who ate at home two hours before.

Pollitt and Matthews also cite two studies which, although they go back to 1982, are included here because they were conducted in the UK (Dickie and Bender, 1982). The first was conducted in three London schools and included 277 12-year-olds and 260 15-year-olds; the second involved 108 16 and 17-year-olds from four boarding schools. In each study breakfast and no breakfast groups were tested on various measures of cognitive performance, but neither study found differences.

Omitting breakfast interferes with cognition and learning, especially in nutritionally at-risk children. At the very least, breakfast improves school attendance and enhances the quality of the students' diets.

Pollitt and Matthews point to design weaknesses in both the UK and Israeli studies, but in commenting on their own summary they admit that no definitive conclusion can be drawn from existing data on the short-term benefits of

breakfast on cognition and school learning, or the mechanisms that mediate this relationship. However, they go on to state:

> *The pooled data suggest that omitting breakfast interferes with cognition and learning, an effect that is more pronounced in nutritionally at-risk children than in well-nourished children. At the very least, breakfast consumption improves school attendance and enhances the quality of the students' diets.*

It should be remembered that in reaching the above conclusion Pollitt and Matthews were taking into account all the papers presented at the symposium, which included studies undertaken on children in the third world as well as on adults.

Connor (1991) picked up the theme of inconsistency of research findings in his own review of the literature on diet and performance in children. One article, itself a review, was the work of Hobbis (1990), who described the outcomes of studies in the UK which examined the effect of missing breakfast on children's learning performance. The conclusion was that if a child was used to having little or no breakfast then no inconsistencies would be observed in performance, but that if a child was used to having breakfast there would be a reduction in attention and concentration 'and thus some inhibition in progress' when breakfast was missed. Hobbis concluded from UK studies that missing breakfast matters to children who normally eat it, but not to others.

Another item included in Connor's review was a study undertaken by Crombie and colleagues (1990). They attempted to replicate a study conducted by Benton and Roberts in 1988 which concluded that a supplemented diet may bring about a positive enhancement of learning ability, but were unable to observe any significant effect from supplementation. Furthermore, says Connor, further examination:

> *indicated that this negative outcome did not result from poor compliance to the procedures on the part of any of the families, nor was there any evidence that this later sample of children had a generally better intake of nutrients in the first place.*

Nelson and colleagues also found no evidence that learning ability was limited by the quality of diet. The study undertaken by Nelson and colleagues (1990) (not included in Connor's review) and reported in the *British Journal of Nutrition* found no significant difference in intelligence between matched pairs of 51 7 to 10-year-olds, half of whom were randomly assigned a dietary supplement while the remaining half took a placebo. They were tested both before the supplement began and after a month, but the researchers found no evidence that learning ability was limited by the quality of diet. Their study has been criticised, however, on methodological grounds (Carroll, 1995).

Schoenthaler concluded that dietary supplements are effective for all children, not just those who are undernourished. Schoenthaler and colleagues (1991, and cited in Connor's review) worked in California with an initial sample of 615 12 to 16-year-olds and concluded that dietary supplements do produce cognitive

effects which operate in a predictable manner and which may be observed among children already receiving an apparently good diet.

Connor's judgement on the issue of inconsistency among studies investigating links between nutritional status, learning and intelligence is that:

> *Whether dietary treatment is considered at all or whether it is deemed to be potentially useful, is very much a matter of faith, subjective judgement or prejudice. Those individuals who believe in the significance of dietary treatment will continue to interpret research findings in accordance with their viewpoint, and those who fail to believe will continue to do the reverse.*

From a selective review of the literature on the effects of breakfast on cognition and school performance, Pollitt (1995) acknowledges the impossibility of reaching definitive conclusions about well-nourished children but concludes that:

> *In at-risk subjects... a morning and overnight fast had diverse effects on cognition, particularly the speed of information retrieval in working memory...Available information suggests that brain function is sensitive to short-term variations in the availability of nutrient supplies.*

4.8 Evaluations of breakfast programmes

Research into the effects on educational achievement of national feeding programmes are thin on the ground. The American review quotes Birkenshaw (1990) whose survey of 3rd, 4th and 8th grade children in Pennsylvania showed that frequency of eating breakfast was positively related to performance on reading and math questions on a standardised test, but although Birkenshaw's work seems to be concerned with longer-term effects than do most of the nutritional studies already summarised it falls short of being an evaluation of a feeding programme.

Glewwe and colleagues (1999) considered the value of intensive nutritional supplementation programmes in the context of improving the attainment of children in the Philippines. Taking 'one of the more optimistic assessments' of the value of such programmes as a model, they calculated that the improvement would be small, and concluded that improving the quality of schools could have as much direct effect as learning as many years of a continuous and intensive supplement diet. The team considered that 'the relationship between nutrition and learning is not likely to be of overwhelming importance either for World Bank policies or in accounting for economic growth'.

Symons and colleagues (1997) acknowledge that 'research has yet to confirm a direct, empirical and irrefutable link between comprehensive school health programs and academic achievement'. While suggesting that public nutritional programmes help, Lewitt and Kerrebrock (1997) imply that a need for them remains for the long term and that more evaluations are required:

> *Available general population data are not recent enough to allow for an assessment of the impact of several major public programs designed to address the risk of inadequate nutrition among children ... [but analysis of the data does show]... a higher than expected, albeit declining, level of stunting among program participants... careful consideration of the growth stunting indicator should remain an important part of policy discussions on public nutrition programs.*

Pollitt (1995) reviewed findings from three national breakfast programmes, one in the US, one in Jamaica and one in Peru. The school breakfast programme in the US provided students with breakfast 'at full price, reduced price, or for free, according to uniform national eligibility criteria based on family income and size'.

Pollitt's review states that in 1995, surprisingly, no (national) data evaluating the effects of breakfast consumption through this programme were available, but he cites a national evaluation (Radzikowski and Gale, 1984; Hanes and colleagues, 1984) which did not include cognitive or educational outcomes. This found that while the school breakfast programme had no direct effect on the nutrient intake of the students it did make students more likely to eat breakfast. The likelihood was limited, however: in 1991/2 the school breakfast programme was available to slightly more than half the nation's students, but fewer than 20% of those to whom it was offered participated (Devaney and colleagues, 1993).

However, work by Meyers and colleagues (1989), reviewed both by Pollit and separately for the current review, set out to test the hypothesis that the school breakfast programme was associated with improvements on standardised test scores and in lateness and absence rates. The sample included all children in grades 3 to 6 in 16 elementary schools in a large and ethnically diverse school district in Massachusetts. All were participants in the programme, which had started in that district in 1986, and all were from low-income groups. Changes in scores on a standardised achievement test and in rates of absence and lateness before and into the implementation of the programme (a year later) were compared with those of children who also qualified for the school breakfast programme but did not participate. Meyers and colleagues found that after controlling for other factors, participation in the school breakfast programme improved both the 1987 test scores and lateness and absence rates. The programme effects were clearest among boys and Hispanics. The researchers conclude:

> *The academic improvements demonstrated in this study could be due to either the immediate effects of a morning meal eaten at the start of the school day, a more long-term benefit related to improved 24-hour dietary intake, or a combination of both. If the improvement is related to the long-term effect of improvements in dietary status, there may be even greater measurable effects.*

The Jamaican study included in Pollitt's review was conducted by Powell and colleagues (1983), who measured the effects of giving or not giving a standard Government meal of milk, and either a banana cake or pastry containing minced meat and vegetables, to undernourished children with poor attendance rates. 115 children took part over three months. The breakfast was found to have no effect on height or weight over this time but truancy declined and there were significant effects on an arithmetic test. The researchers believed attendance and therefore achievement improved simply because the children wanted the meal.

The Peruvian study (Jacoby and colleagues, 1995) randomly allocated 10 schools in which the school breakfast programme either was or was not available. The children taking part were 'notably stunted and overweight for their height', a shape common among some populations where malnutrition is endemic, possibly because of excess water. Over 15 days, researchers looked for improvements in nutrient intake, school attendance and test performance. Jacoby and colleagues found that the dietary intake of the children in the programme schools increased significantly and attendance improved, while attendance dropped in the schools that were not involved in the programme. The greatest benefits were seen in the most nutritionally at-risk children.

Pollitt's comment on the three studies he reviewed was that the data were insufficient to enable definitive conclusions to be drawn about the educational benefits of the programmes. He identifies the lack of research in this area as a wide gap in the present literature:

> *Data from other areas of nutrition and behavioural research suggest that highly prevalent nutrient deficiencies (eg iron deficiency and anaemia) affect cognition, and that they can be prevented or remediated by a school breakfast program... Current evidence that breakfast makes a difference in school performance will be greatly enhanced by such new data.*

The literature review, already quoted, prepared by a US working committee on education and labor (Working Committee on Education and Labor, 1994), is more firmly optimistic, and among earlier studies cites Ho and colleagues (1991) who found that children who eat a school lunch have a better nutritional intake than children who eat a bag lunch brought from home or purchased from a vending machine. None of these studies evaluated the effects of the meal on achievement, however.

4.9 Nutrition and attainment : Summary

The research literature on the possible relationship between nutrition and attainment is extensive. Much of this literature indicates that nutrition can affect learning and attainment. Many studies report that better nutrition is associated with:

- Positively influencing neurological development of the brain and cognitive processes.
- Short-term and long-term attainment and behaviour conducive to learning.

However, there is considerable debate over the claims of such studies. Many of the studies which have found no effects of nutrition and dietary supplements are based in the UK. There have also been inconsistencies in the research design of studies, which make comparisons and replication difficult. Therefore, the picture is inconclusive. What appears to be clear is that effects of nutrition appear bound up with other factors such as family, community and levels of poverty.

5: How are mental health and risk behaviours related to school attainment?

5.1 Exposure to violence

Exposure to violence has lifelong effects on learning. Symons and colleagues (1997) quote Prothrow-Stith and Quaday (1996) whose research on African-American children leads them to this stark conclusion. Common characteristics of such exposure are lack of interest in school, behaviour problems at school, low grades, low self-esteem and a high drop-out rate, all of which threaten academic performance. Symons and colleagues (1997) note there are many other studies reaching similar conclusions and linking intentional injury risks with gang-related activities, destruction of school property, and truancy: Adcock and colleagues, 1991, Felgar, 1992; Landen, 1992; Lockwood, 1993; Obiakor, 1992 and Shore, 1995.

According to Symons and colleagues, Kurtz (1994) found that abused children exhibited significant differences in academic achievement and intellectual functioning compared to control group counterparts, while children who witness chronic violence may exhibit poor concentration, shorter attention span, and a general decline in academic performance (Lorion and Saltzman, 1993). They are fearful, cautious, and withdrawn; they often manifest delayed language development and an overall sense of powerlessness (Prothrow-Stith and Quaday, 1996). Their sleep is often disturbed, and they can suffer from headaches, stomach distress, and asthma attacks.

5.2 Persistent childhood habits

A UK research team in the early 1990s (Polnay and colleagues, report undated) investigated 'the natural history of a number of common childhood habit problems' (sleeping, eating, night and day wetting, soiling and somatic problems such as stomach upsets and headaches). Their aim was to identify associations that might further understanding of how the problems could be dealt with: one of the associations being sought was education.

The research was based on a very large sample. The BCS70 dataset, which was an ongoing study of all children born in the UK during the week of 5-11 April 1970, provided information about 13,135 subjects at age 5 and 14, 904 at 10 and 11, and 631 at 16. Interviews with mothers, self-completion questionnaires filled in by the subjects, reports from teachers and medical examinations were used to gather data on the physical, social and educational progress of these children, as well as on epidemiological factors, their medical histories, use of health and social services, family and social backgrounds, lifestyles and behaviours.

No associations with education were apparent at age five, presumably because most of the children were too young to have been influenced by school, and

Polnay and colleagues explain that the data on education were unsatisfactory for age 16, so were not used. At age ten, however, significant associations emerged:

- Children with persistent bedwetting were more likely to have lower school attainments than those without, as well as parents who showed a low level of interest in their education.
- Children with severe, persistent wetting and soiling were more likely to have lower school attainments – and half of these were reported as having great difficulty at school.
- Children with eating or appetite problems were more likely to have school difficulties, as were children with headaches and persistent stomach upsets.

The report is presented principally through statistical analyses and there is little discussion of the findings. The authors make reference to follow-up studies in 1999 and 2000, so perhaps a final report drawing everything together is in preparation. Polnay and colleagues do comment, however, that poor school attainment should be seen as the product, rather than cause, of the habits.

Boys, in particular, with persistent bedwetting problems may be likely to have problems at school. For example, Byrd and colleagues (1994) report that in their large study 'there was a previously unreported association between enuresis in males and early grade retention.'

5.3 Tobacco, alcohol and other drug misuse

Tobacco, alcohol and other drug misuse was one of the risk behaviour categories that Symons and colleagues (1997) considered to have the greatest impact on health. Reviewing the literature that investigated such drug misuse in relation to achievement at school, Symons and colleagues found abundant evidence that adolescents who use drugs have lower grades and more negative attitudes to school. They have increased absenteeism and demonstrate more frequent 'risk-taking behaviour' related to delinquency (Dryfoos, 1990; US Department of Education, 1992; Andrews and colleagues 1991; Sculenber and colleagues, 1994; Eggert and Herting, 1993; Block and colleagues, 1991; Braggio and Pishkin, 1993; Evans and Skager, 1992; Thorolfur and Vilhjalmsson, 1991).

The same body of research showed that illegal drug use may predict dropping out of school and has been linked to truancy. It is associated with reduced attention span and lower investment in homework and has been linked to increased association with deviant subcultures that support a lack of attachment to school.

In Scotland, West and colleagues (1990) have found smoking to be a predictor of low school attainment. It is clear from the various studies that using tobacco, alcohol and other drugs can interfere with brain and personality functions and can adversely affect adolescent development. The research further indicates that drug use can interfere with cognitive functioning, memory, sensation and perception; can stifle creativity and thwart ambition; and interferes with the brain's ability to receive, sort, and synthesize information. Drugs, say Symons

and colleagues, adversely affect adolescent development and endanger the successful transition to adulthood.

5.4 Sexual behaviour resulting in pregnancy

Symons and colleagues cite research showing that after childbearing, adolescent women face increased risk of reduced educational achievement (Dryfoos, 1990; Nord and colleagues, 1992). They found evidence that younger women who bear children are less likely to complete high school than their older counterparts (Upchurch and McCarthy, 1990) and that adolescents who become pregnant are less likely to be involved in school activities, tend to have lower grades, and continue to be likely to participate in sexual risk behaviours (Scott-Jones, 1993; Caldas, 1994; Males, 1993).

5.5 Absence from school

A study by Malcolm and colleagues (1996) found that absence from school, for whatever reason, including ill health, had a detrimental effect on the quality of pupils' school work. The evidence for this was based on primary and secondary teachers' accounts. Teachers agreed that absence impaired pupils' learning. This was particularly important for 'sequential' subjects like mathematics. However, some teachers felt that good learning support could compensate for pupils' absence. Teachers felt that occasional absences taken over a long period could effect pupils' more than a short continuous absence. The study indicates that other complex and interrelated factors (pupils' backgrounds and circumstances) which influenced attendance could also effect their academic performance.

5.6 Mental health, risk behaviours and attainment : Summary

- Poor mental health can be manifested in a range of problem behaviours that can affect concentration, difficulties at school and low school achievement.
- Some studies highlight that risk taking involving behaviours that affect physical and mental health, such as drug misuse, can have a long term detrimental effect on health, particularly where substances affect brain functions and personality. Some pupils who misuse certain substances including tobacco, alcohol and illegal drugs, can have lower school grades and develop negative attitudes to school.

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